

# ***MC-1000WU-20A High-Resolution B/W Camera User's Guide***

Literature No. SOCU007

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### ***About This Manual***

This User's Guide provides installation, operation, and maintenance information for the MC-1000WU-20A black and white video camera.

### ***How to Use This Manual***

This document contains the following chapters:

- Chapter 1 – Introduction
- Chapter 2 – Specifications
- Chapter 3 – Installation
- Chapter 4 – Operation
- Chapter 5 – CCD Circuit Description
- Chapter 6 – Cleaning Instructions
- Appendix A – Functional Block Diagram
- Appendix B – Timing Diagrams

Refer to the appropriate chapter for more information or for instructions concerning procedures or practices.

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# General Description

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This User's Guide describes installation, operation, and maintenance for the MC-1000WU-20A video camera.

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## 1.1 Features

The Texas Instruments MC-1000WU-20A camera features the Texas Instruments TC215 solid-state monochrome charge-coupled-device (CCD) image sensor. The camera is for vision system applications requiring high-resolution and high-sensitivity operation. The camera features include:

- TV frame rate, 15 Hz
- High sensitivity, 0.35 lux typical
- 12  $\mu\text{m}$  square pixel
- TI-Virtual Phase CCD technology
- High blue response
- High near-IR response
- Electron-hole recombination antiblooming
- 100% optical fill factor

## 1.2 Introduction

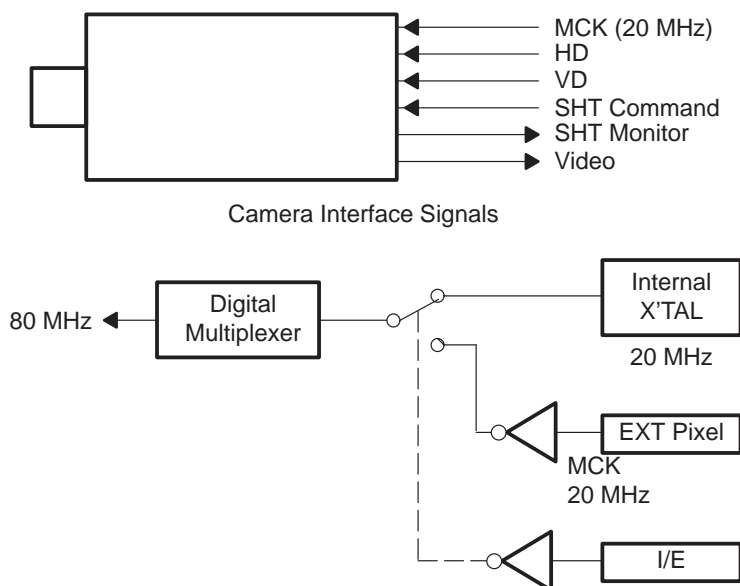
The MC-1000WU-20A is one of a series of high-resolution video cameras that employs TI's mega-pixel CCD image sensors. The cameras are intended for scientific and industrial imaging applications where image data processing is required.

The MC-1000WU-20A camera employs the TI TC215 full-frame CCD image sensor, which features 1,017,000 active photosites, resulting in a very-high-resolution image. The TC215 sensor provides high sensitivity and good spectral response as a result of the TI patented Virtual Phase technology.

The TC215 sensor measures 17.2 mm diagonally and features 12- $\mu\text{m}$  square pixels. The square pixels permit symmetrical image measurement in both the X and Y axis. The photosite has a 100% fill factor and is responsive to wavelengths in the ultraviolet through the visible and into the near-infrared spectral regions. The camera outputs composite analog video at a 20-mega-pixel per second data rate. Two operating options can be selected - a normal operating mode and a programmable shutter mode. In addition, the camera provides for auto-iris control.

A mechanical shutter or strobe light is recommended for most MC-1000WU-20A camera applications. The shutter operation is synchronized to the camera by supplying an external shutter command signal. The shutter may operate from a minimum integration time of 1/2500 second to 1/125 second or 10 frames/s maximum. Figure 1-1 shows the camera interface options and mode selection.

Figure 1-1. MC-1000WU-20A Interface Options and Mode Selection



### 1.3 Physical Description

The MC-1000WU-20A camera is housed in an aluminum case 210.6 mm long (excluding lens) by 68.0 mm high by 68.0 mm wide. It is self-contained except for power supply and monitor. The camera weighs 2.09 pounds.

The MC-1000WU-20A offers a standard TV C-mount lens attachment with an adjustable lens locking ring to allow precise adjustment of the lens back focal length. A variety of lenses or mechanical shutters may be used.

**(??Page 3–4 says three ??)**Two standard  $1/4 \times 20$  threaded tripod mounting holes on the baseplate allow secure mounting.

## 1.4 Equipment Supplied

After unpacking the camera and before discarding the packaging materials, inventory the shipment for the following items:

- MC-1000WU-20A CCD camera
- Lens (optional) (not supplied)(**??If not supplied, it won't be in the inventory??**)
- MC-1000WU-20A CCD Camera User's Guide
- Auto iris connector
- Power connector (optional power supply)
- I/O interface connector (not supplied)(**??If not supplied, it won't be in the inventory??**)

## **1.5 Equipment Required But Not Supplied**

The MC-1000WU-20A camera uses the full-frame TC215 CCD image sensor. This full-frame format sensor requires a mechanical shutter or an electronic light strobe to prevent image smear. The shutter or strobe light allows scene information to be captured during either the open time of the shutter or on-time of the strobe light. The transfer or read-out of the captured scene information is performed during the closed time of the shutter or off-time of the strobe. Once the shutter or strobe light is chosen, an appropriate lens may also be selected.

The MC-1000WU-20A camera supplies analog video at either a 15-Hz frame rate in the TV mode or a 10-Hz frame rate in the shutter mode and can be displayed directly to a video monitor capable of those frame rates. However, many applications require the addition of a custom or commercially available frame-buffer or other video processing equipment. This hardware will enable the user to capture and digitally process the scene information. The MC-1000WU-20A is presently supported by several manufacturers of video processing hardware and software systems. Most manufacturers have application notes available describing the interface required.

# Specifications

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This chapter lists specifications for the MC-1000WU-20A camera and describes the interface circuit.

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## 2.1 Specifications

Table 2–1 lists the specifications for the MC-1000WU-20A camera.

*Table 2–1. Specifications*

Item	Specification
Imager	Texas Instruments TC215 Full-Frame CCD
Resolution	1024(H) × 1024(V) (total imager) 1000(H) × 1017(V) (active pixels)
Pixel size	12 μm × 12 μm
Imager size	H: 12.2 mm V: 12.0 mm
Synchronization	Internal/external (jumper selectable)
TV mode	1050 lines/frame (33 blank lines) 15 frames/sec non-interlace
Shutter mode	1050 lines/frame (33 blank lines) 10 frames/sec (max)
Sensitivity	0.29 lux (max) 0.35 lux (typ) 0.41 lux (min) 1/30 integration Video output: 100 IRE S/N ratio: 48 dB Light source: T=2870°K
S/N ratio	48 dB
MTF	10 MHz chart, 35% (typ), 500 nm
White clip	0.90 ±0.05 V
Setup level	50 ±10 mV
Output dc level	0.30 ±0.05 V
Sync level	0.30 ±0.015 V
Supply voltage	+5 ±0.15 Vdc –12 ±0.4 Vdc +12 ±0.4 Vdc
Power consumption (typical)	+5 V at 0.820 A +12 V at 0.180 A –12 V at 0.150 A
Non-uniformities	Total black and white pixel non-uniformities, less than 20. Vertical line non-uniformities, less than 5.
Shading (maximum)	<u>10%</u> <u>100%</u>
Horizontal	15 mV                      50 mV
Vertical	20 mV                      70 mV
Vertical frequency	15.46 Hz
Horizontal frequency	16.234 kHz
Gamma	1.0



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*Table 2–1. Specifications (Continued)*

<b>Item</b>	<b>Specification</b>
Operating temperature	–10°C to +45°C
Storage temperature	–30°C to +85°C
Dimensions	68 (W) × 68 (H) × 210.6 (D) mm
Weight	2.09 lbs

## 2.2 Interface Circuit

The input interface circuit of VD, HD, and MCK shown in Figure 2–1, consists of one SN75124 input gate pulled up through a 4.7-k $\Omega$  resistor to 5 Vdc and pulled down to ground through an optional 100- $\Omega$  resistor. The optional pull down is selected by jumpers JP1 (MCK), JP2 (HD), and JP3 (VD).

Figure 2–1. Input Interface Circuit of VD, HD, and MCK

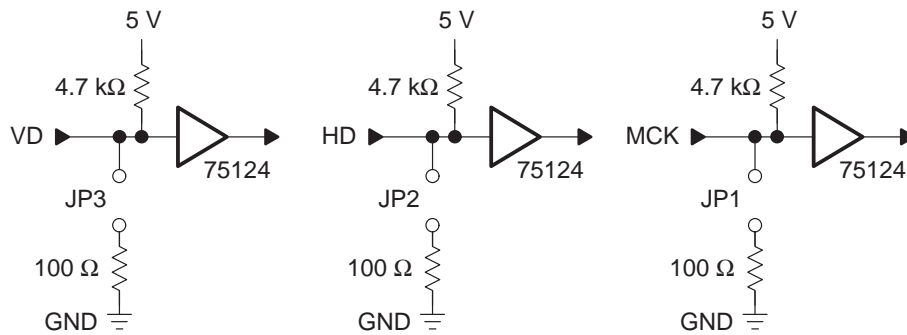
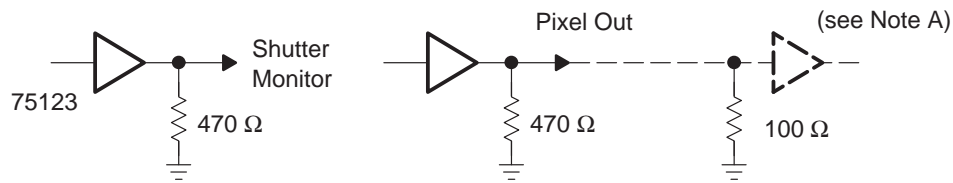


Figure 2–2. Output Interface Circuit of Pixel and Shutter Monitor



NOTE A. For pixel clock receiving, pull domain resistor 100  $\Omega$  is recommended.

# Installation

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This chapter describes interface assignments and gives instructions for installing and testing the camera.

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<b>3.3 Post-Installation Test</b> .....	<b>3-5</b>

### 3.1 Interface Assignments

Depending upon the application, it may be necessary to build a camera cable that contains some combination of the signals listed below:

*Table 3–1. Auto Iris Connector Pin Assignment*

Pin Number	Signal Name
A	Video signal
B	GND
C	+12 V
D	NC
E	NC

**Note: Connectors**

Camera side: PRC05-R5M (Tagimi)

Cable side: PRC05-P5F (Tagimi)

*Table 3–2. Power Connector Pin Assignment*

Pin Number	Signal Name
A	+12 V
B	+12 V
C	GND
D	+5 V
E	+5 V
F	GND
G	–12 V
H	GND

**Note: Connectors**

Camera side: R03-R8F (Tagimi)

Cable side: R03-PB8M (Tagimi)

*Table 3–3. Video Connector (BNC Connector)*

Pin	Signal Name
Center pin	Composite video
Shell	Video RTN

Table 3–4. AUX Connector Pin Assignment

Pin	Signal Name	I/O	Trigger	Interface
1	MCK RTN			
2	Horizontal Drive RTN			
3	Vertical Drive RTN			
4	Pixel Clk Out RTN			
5	Shutter RTN			
6	Shutter Monitor RTN			
7	Internal/External RTN			
8	GND			
9	MCK IN	I		SN75124N
10	Horizontal Drive	I	Negative	SN75124N
11	Vertical Drive	I	Negative	SN75124N
12	Pixel Clk Out	O		SN75123N
13	Shutter CMD	I		SN74LS14N
14	Shutter Monitor OUT	O	Negative	SN75123N
15	Internal/External	I		

**Note: Connector Information**

External mode: short 7 pin——15 pin

Internal mode: open 7 pin——15 pin

Connectors: Dsub 15 pin female connector, #4-40 (cable side)

## 3.2 Installation Procedure

The following paragraphs describe installation procedures for the MC-1000WU-20A camera.

### 3.2.1 Mounting the Camera

The camera can be mounted using any one of (??Two on page 1–4??) three  $1/4 \times 20$ -thread mounting holes located on the camera base plate.

### 3.2.2 Connecting an Auto-Iris Lens

Most auto-iris lenses can be used with MC-1000 series cameras. Connect the auto-iris lens to the MC-1000WU-20A camera per the auto-iris connector pin-out table in Section 3.1 and the lens wiring schematic provided by the lens manufacturer.

### 3.2.3 Connecting a Standard Lens

A number of standard C-mount or shutter attachments may be used with the camera. The camera employs a lens locking ring to fix the minimum distance between the rear lens element and the CCD imager.

### 3.2.4 Connecting the AC/DC Power Supply

The PS-1000 power supply is recommended for use with the camera, because it already has the proper power connector installed. A bench supply can also be used, provided that the bench supply output meets the power requirements of the camera listed in Chapter 2.

### 3.2.5 Connecting the Monitor

Video may be viewed directly from the camera by attaching a video cable to the video input jack of a TV monitor. The monitor must be capable of 15 Hz vertical synchronization. The video may also be the input source to commercially available frame-buffer or other video processing hardware. The video signal should be properly terminated into a 75-ohm load. A mechanical shutter or strobe light will be required in most applications.

### **3.3 Post-Installation Test**

When the power and monitor connections have been made, test the camera by applying power to the monitor and the external power supply (if used). The green power-on LED on the camera rear panel should light and an image should appear on the display. It may be necessary to operate the shutter control or frame-buffer hardware to obtain an image. In addition, the lens may require focus adjustment to obtain a sharp picture.





# Operation

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This chapter describes general and external operating procedures for the MC-1000WU-20A camera.

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<b>4.2 External Operation (See Appendix B) .....</b>	<b>4-3</b>

## 4.1 General Operating Procedures

The MC-1000WU-20A camera features high-resolution, stable, very sensitive, linear images from an array of 1000(H) by 1017(V) picture elements. The camera operates as one unit of a user-defined imaging system. Other components typically consist of a mechanical shutter or strobe light, a TV frame-buffer or frame-storage computer or hardware system, an optical system (lens), and a power supply. The MC-1000WU-20A camera operates with little or no operator adjustment after the initial setup period. The following paragraphs give operating procedures for the camera.

### 4.1.1 Turn-On Procedure

The camera does not have a power switch; as soon as power is applied by the power supply, the camera becomes operable. The green LED on the rear panel signals that power is applied to the camera. After connection of the power supply, a picture should appear on a monitor screen within a few seconds. If additional frame-buffer hardware is used in the application, verify that the hardware is working properly.

### 4.1.2 Turn-Off Procedure

To turn off the camera, remove the power connector from the camera, or switch off the appropriate system power supply.

### 4.1.3 Focusing

The MC-1000 series cameras use a lens-locking ring to set the minimum distance between the rear lens element and the CCD imager. Focus the lens by rotating the front lens barrel clockwise or counterclockwise until the image is sharp. If a sharp image cannot be obtained, do the following steps:

- 1) Check lens surface for smears, smudges, or dust. Clean lens surface per lens manufacturer's instructions.
- 2) Check glass cover on CCD imager for smears, smudges, or dust. Clean glass cover with alcohol and a cotton swab. See Chapter 6, Maintenance Instructions, for details.
- 3) Check the distance between the rear lens element and the CCD imager. If necessary, adjust the distance by loosening the lens-locking ring. Remember to tighten the lens-locking ring after adjusting to fix the new distance setting.

### 4.1.4 Adjusting Image Brightness

Image brightness is a function of exposure time (which is fixed in standard TV applications) and lens aperture (F number). The sensitivity of the CCD sensor and the amount of light reaching the sensor through the optical system is a function of scene illumination, optical alignment, and magnification. In most cases, the image brightness can be adjusted by varying the lens aperture. If an image is too dark, rotate the lens aperture ring to a smaller number. This selects a larger lens aperture, allowing more light through the lens.

## 4.2 External Operation (See Appendix B)

- Figure B–1. TV Internal Mode
- Figure B–2. TV External Mode
- Figure B–3. The Relationship of Vertical Sync Out and Mechanical Shutter or Strobe Light.
- Figure B–4. The Relationship of Horizontal Drive Input and Video Output
- Figure B–5. Shutter Internal Mode
- Figure B–6. Shutter External Mode
- Figure B–7. The Relationship of VD Input and HD Input
- Figure B–8. HD Input Waveforms
- Figure B–9. The Relationship of VD Input and C-Sync



# CCD Circuit Description



This chapter describes the TC215 CCD image sensor circuit used in the camera.

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## 5.1 The CCD Array

The TC215 is a full-frame charge-coupled device (CCD) image sensor that provides very-high-resolution image acquisition for image processing applications such as robotics vision, medical x-ray analysis, and metrology.

The image format of the sensor measures 12.0 mm horizontally by 12.2 mm vertically; the image area diagonal is 17.2 mm. The image area contains 1017 active lines with 1000 active pixels per line. Six additional dark reference lines give a total of 1024 lines in the image area, and twenty-four additional dark reference pixels per line give a total of 1024 pixels per horizontal line. The pixels are 12  $\mu$ m square and form precise rows and columns, horizontally and vertically, allowing precise image geometry measurements.

The CCD is a solid-state device, which requires no external adjustment or regular maintenance. Unlike a conventional pickup tube, there are no electromagnetic alignment routines to be observed because there is no electron beam involved.

The full-frame image sensor should be used with a shutter or with strobed illumination to prevent smearing of the image during readout. After image capture (integration time), the readout is accomplished by transferring the charge one line at a time into two serial registers, each of which contains 512 data elements and 12 dummy elements. The typical pixel rate is 20 mega-pixels per second using both serial registers. Operating the TC215 at the typical data rate of one field per frame generates video at a continuous 15 frames per second in the TV mode of operation.

# Cleaning Instructions

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This chapter gives instructions for cleaning the camera.

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6.1 Cleaning .....	6-2

## **6.1 Cleaning**

The camera body, lens, and the CCD imager optical glass window should be kept clean and free of dust and grime. Keeping the lens and the CCD imager window clean enhances the picture, ensuring better results in the camera application. These surfaces can be cleaned with denatured alcohol and a cotton swab. Extreme care should be taken when cleaning the optical glass CCD imager window to avoid breaking the glass.



# Functional Block Diagram

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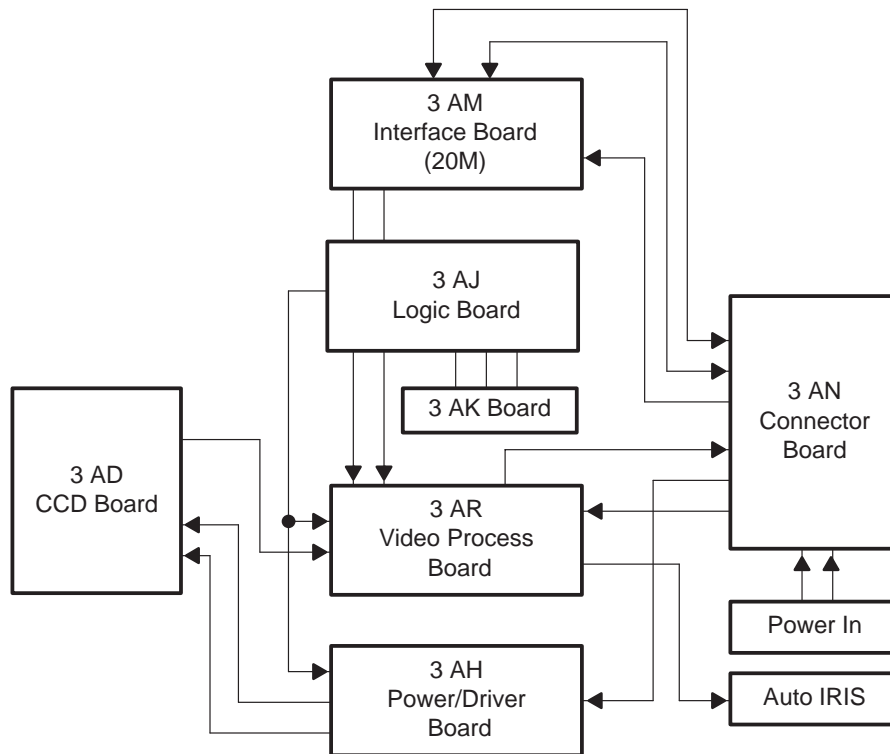
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This appendix contains the functional block diagram for the camera.

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A.1 Functional Block Diagram .....	A-2

## A.1 Functional Block Diagram

Figure A-1. Functional Block Diagram



# Timing Diagrams

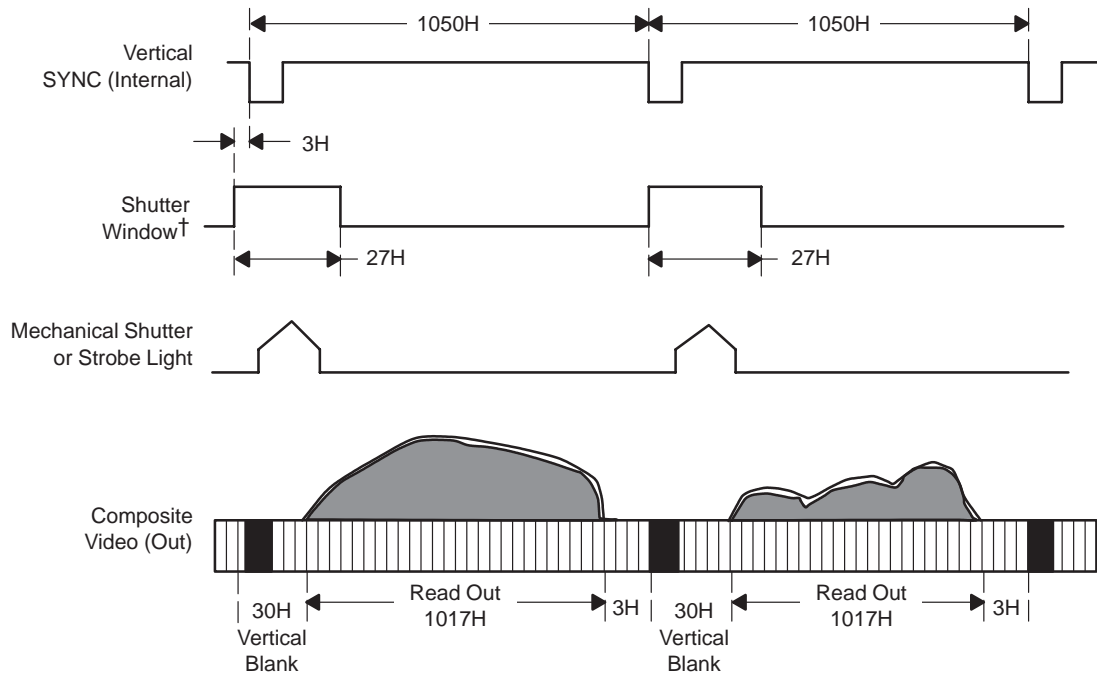


This appendix contains timing diagrams for the camera.

<b>Topic</b>	<b>Page</b>
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## B.1 Timing Diagrams

Figure B-1. TV Internal Mode (see Note)



† No output. This timing indicates CCD state which can be the integration. Shutter or strobe timing have to be synchronized with this window period.

**Note:** This mode is used for camera operation verification.

Figure B-2. TV External Mode

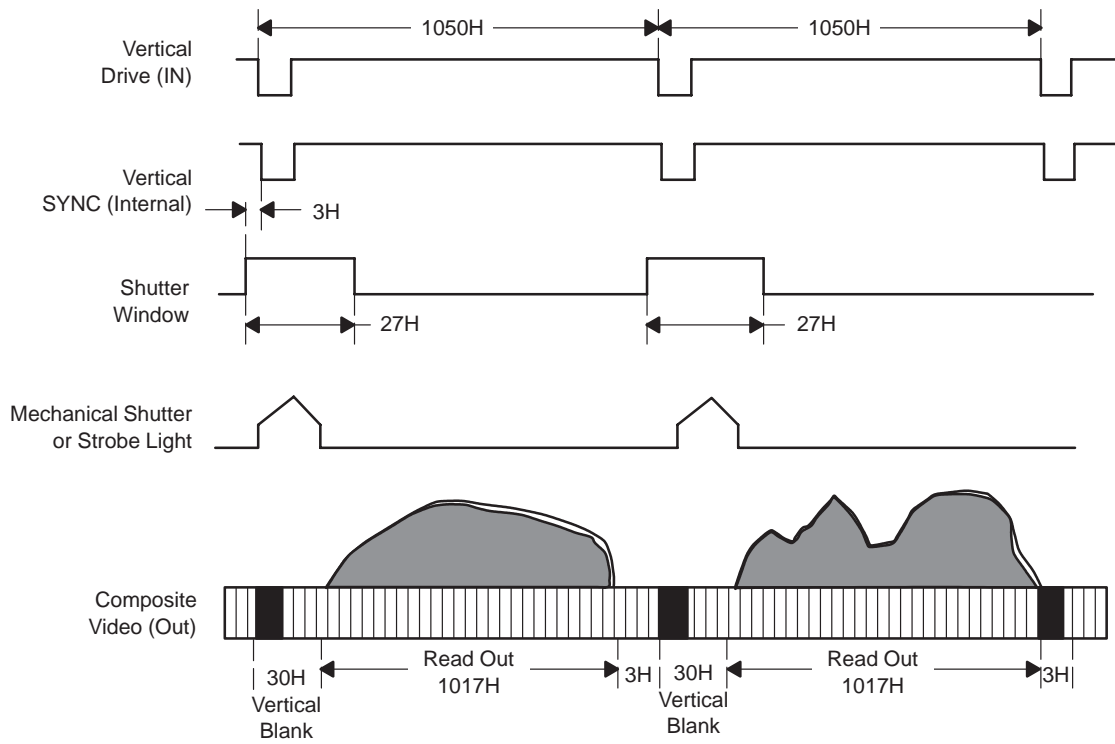


Figure B-3. The Relationship of Vertical Sync Out and Mechanical Shutter or Strobe Light

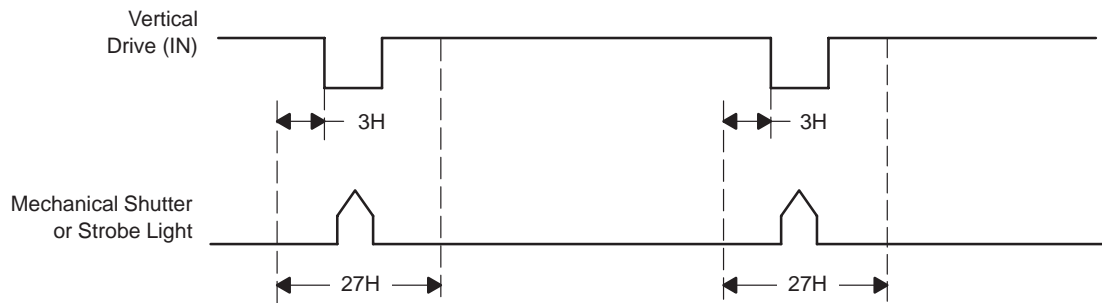


Figure B-4. The Relationship of Horizontal Drive Input and Video Output

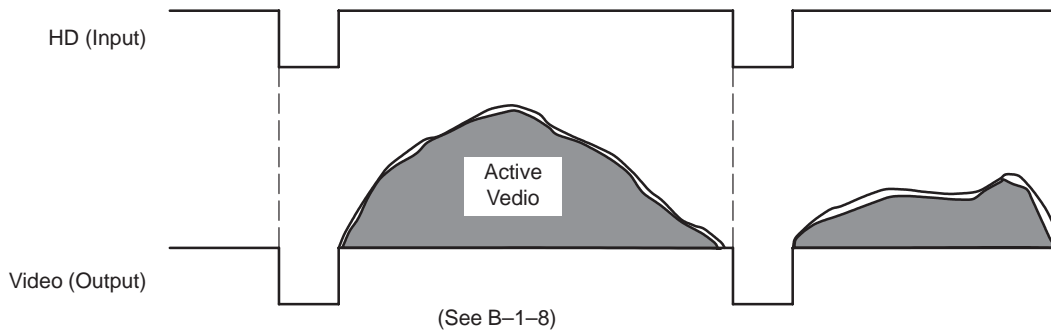
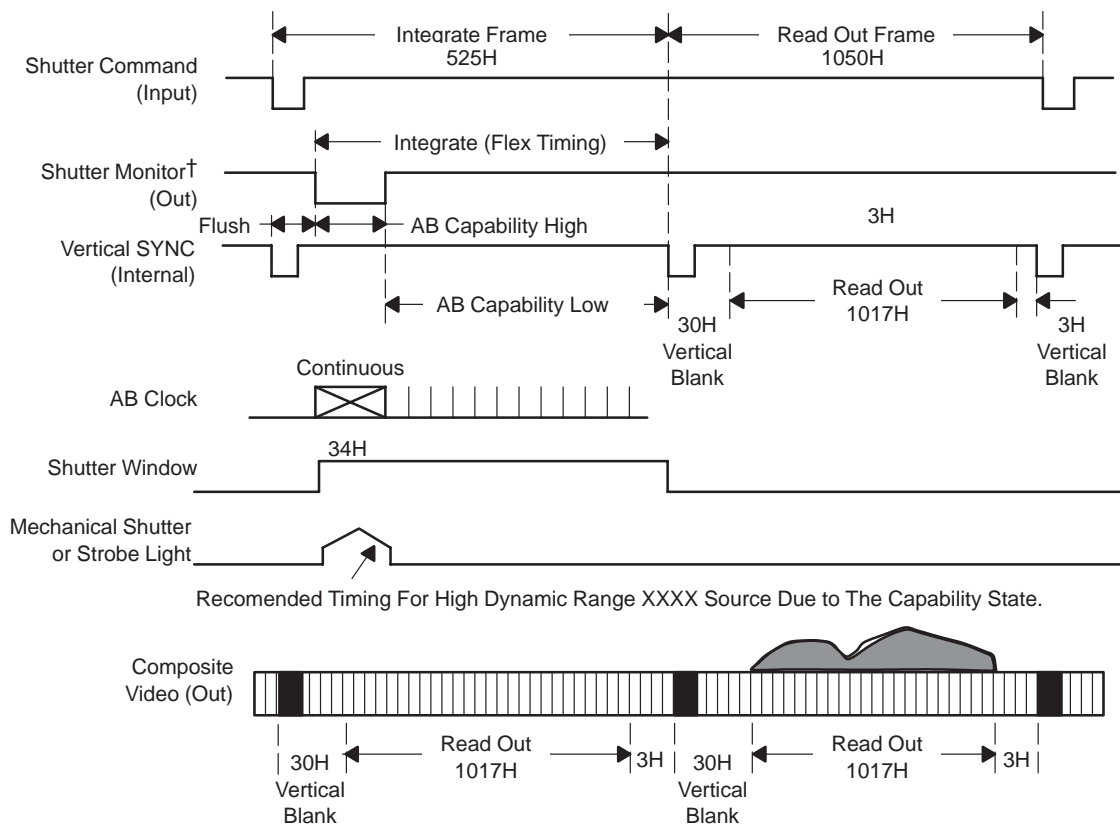


Figure B-5. Shutter Internal Mode



† Fall edge shows starting of CCD integration state. Rise edge shows AB capability state change. The integrate time does not change, but changes AB capability.

Figure B-6. Shutter External Mode

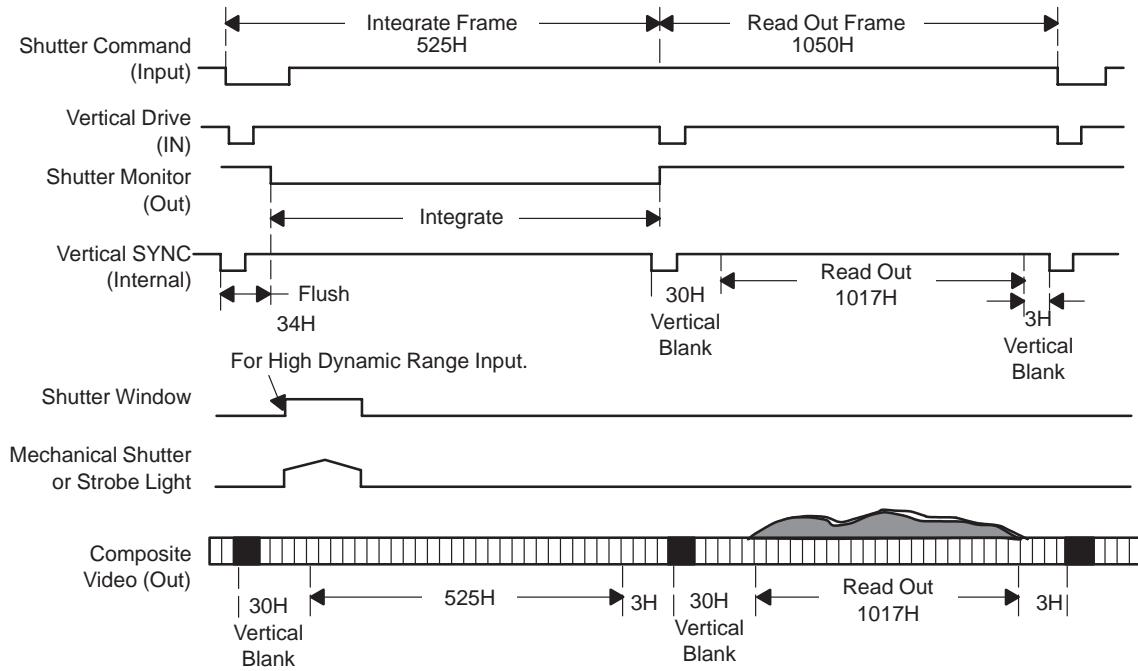


Figure B-7. The Relationship of VD Input and HD Input

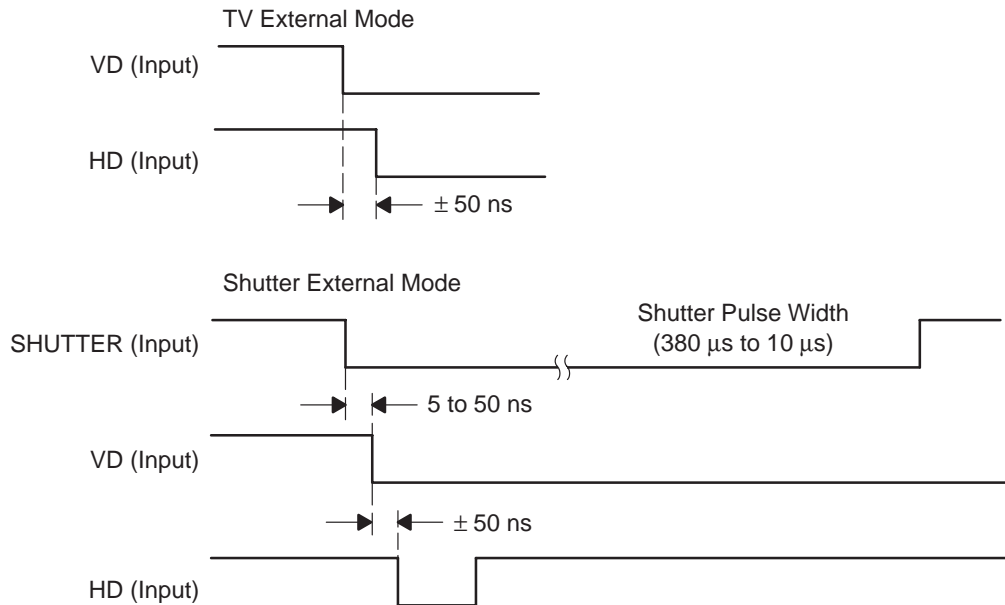


Figure B-8. HD Input Waveform

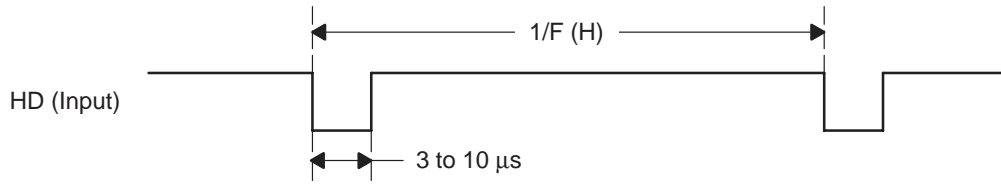
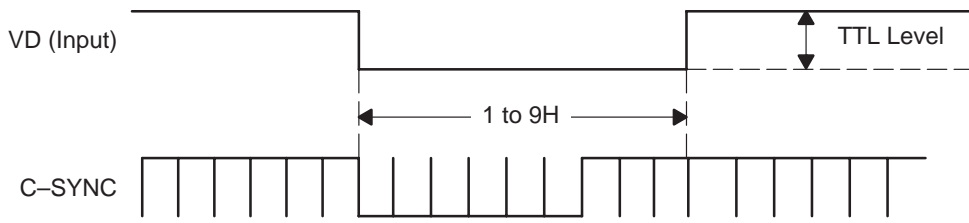


Figure B-9. The Relationship of VD Input and C-Sync





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